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Collareno et al.

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(54) **MUFFLER SHELL BODY WITH INTEGRAL AERODYNAMIC SHIELD**

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F01N 13/18 (2010.01)
F01N 1/08 (2006.01)

(52) **U.S. Cl.**
CPC ***F01N 1/084*** (2013.01); ***F01N 13/1844*** (2013.01)

(58) **Field of Classification Search**
CPC F01N 13/1844; F01N 13/082; F01N 2260/022
USPC 181/227, 228, 282
See application file for complete search history.

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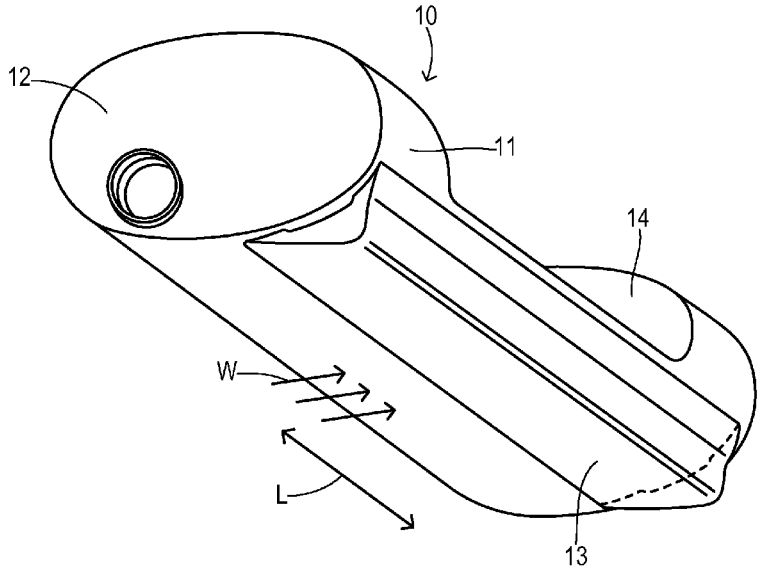
(57) **ABSTRACT**

A muffler shell is formed from a sheet metal blank. The shell comprises a tubular body section which is rolled into a tube so that a first edge of the blank can be welded to an intermediate seam line across the blank. An aerodynamic shield extension projects integrally from the tubular body section between the intermediate seam line and a second edge of the blank to cover a gap between the muffler and adjacent structures when installed on a vehicle.

21 Claims, 5 Drawing Sheets



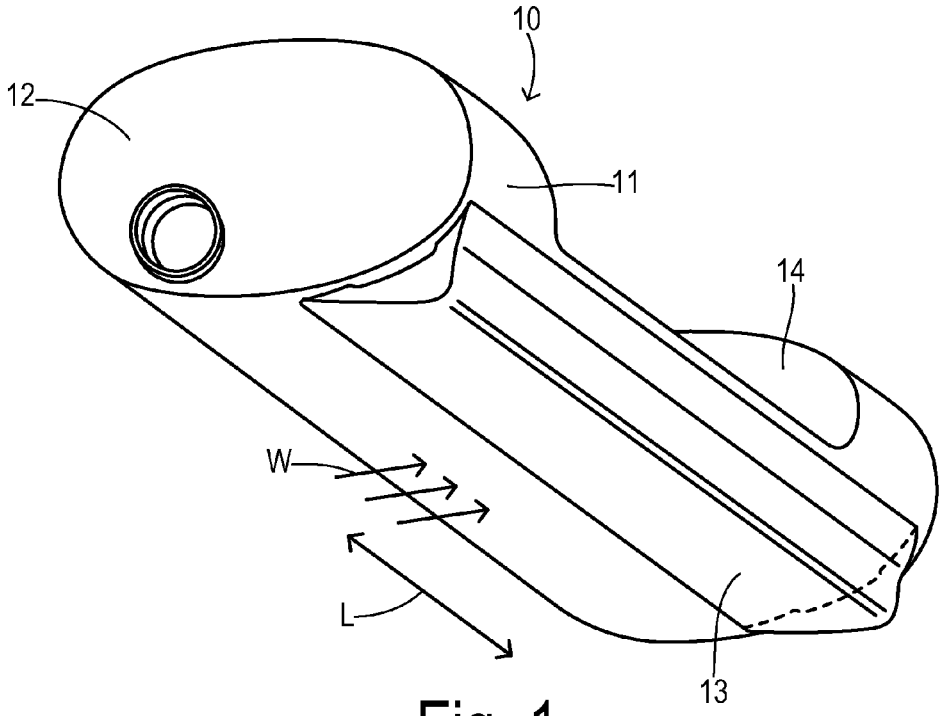


Fig. 1

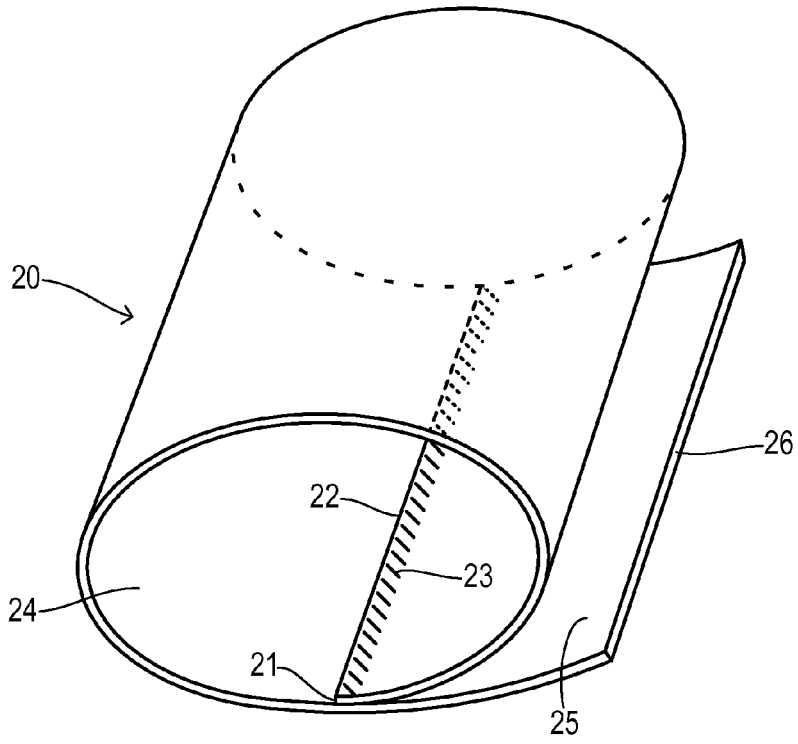


Fig. 2

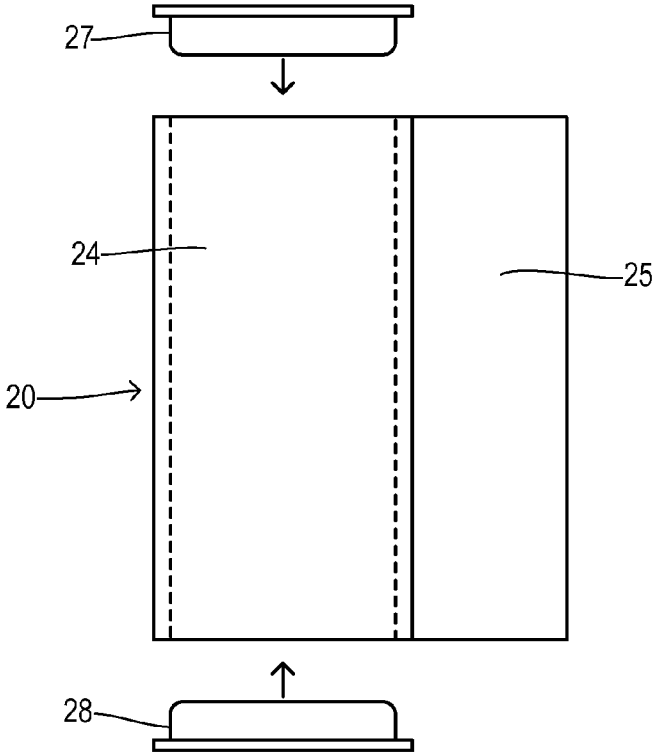


Fig. 3

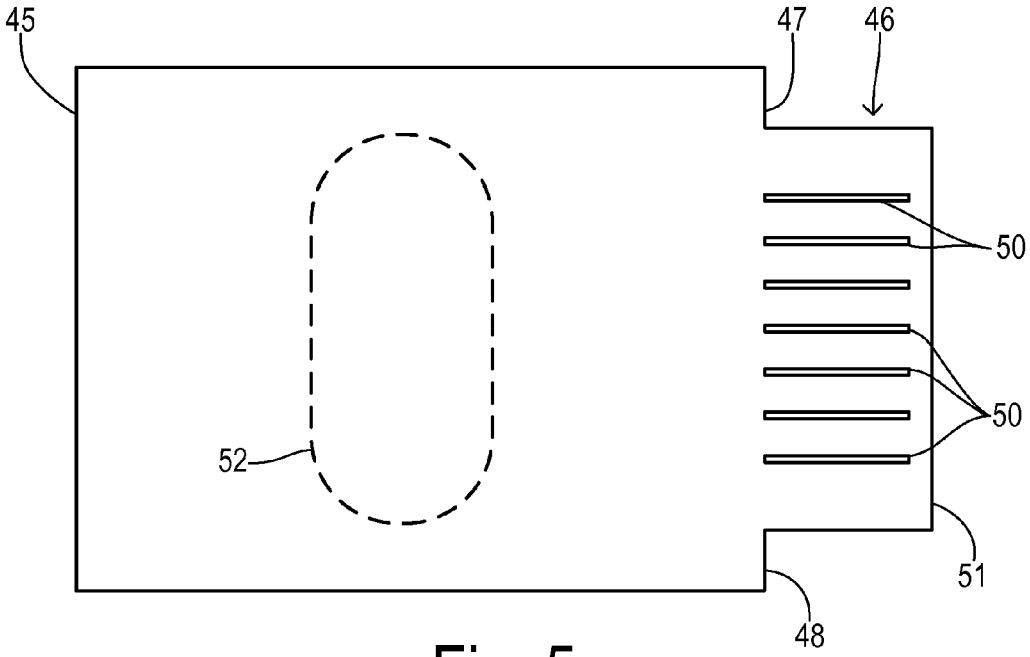


Fig. 5

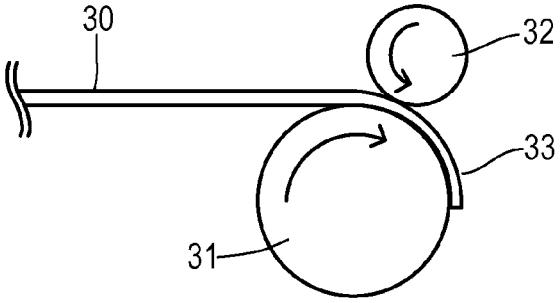


Fig. 4A

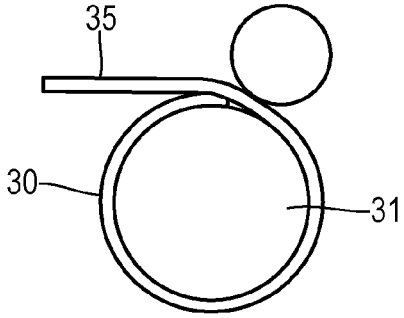


Fig. 4B

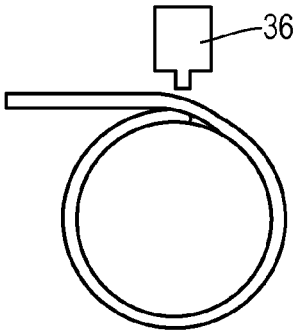


Fig. 4C

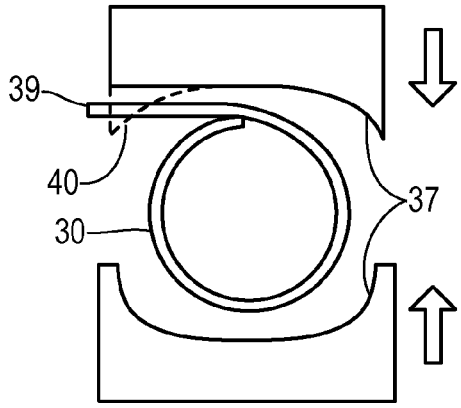


Fig. 4D

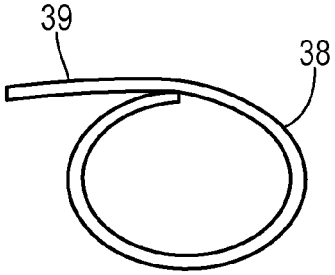


Fig. 4E

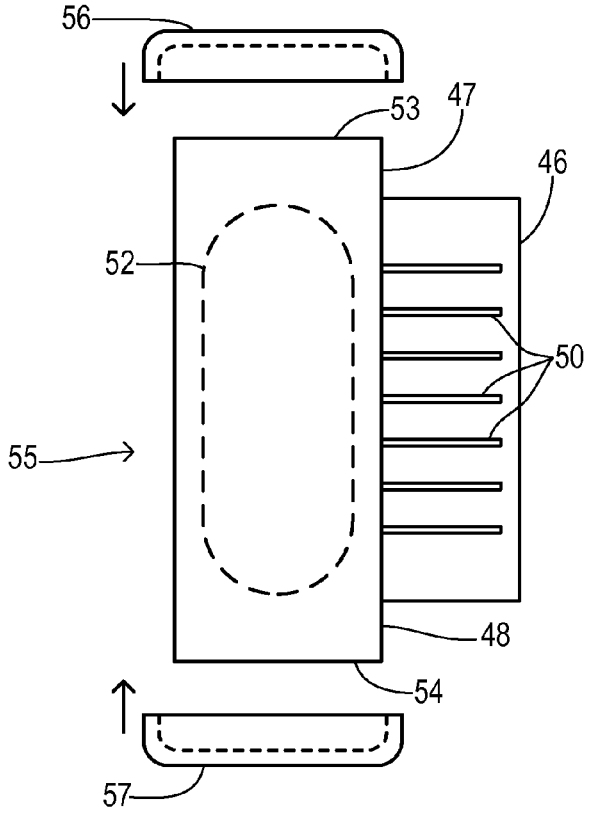


Fig. 6

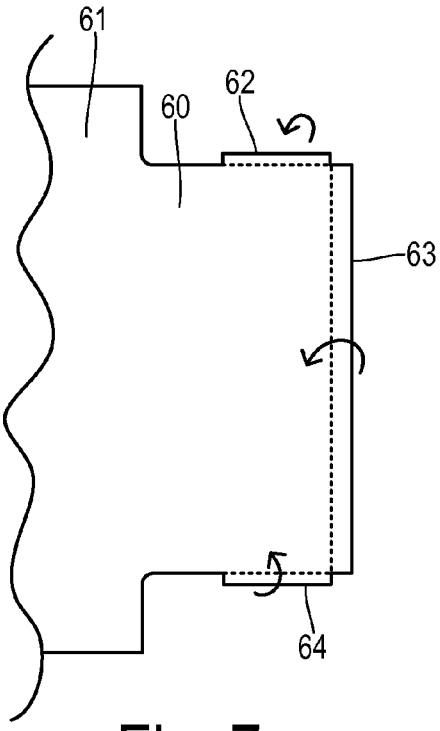


Fig. 7

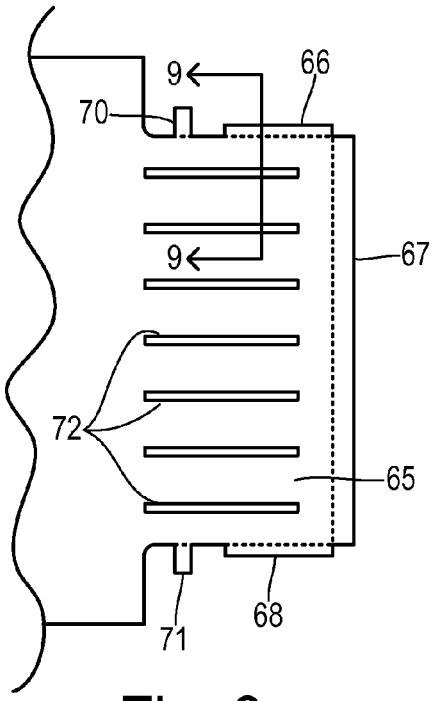


Fig. 8

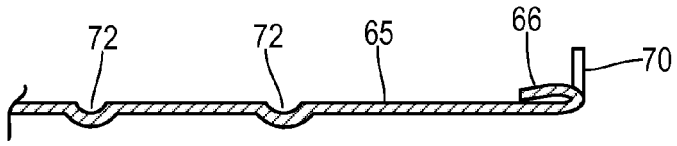


Fig. 9

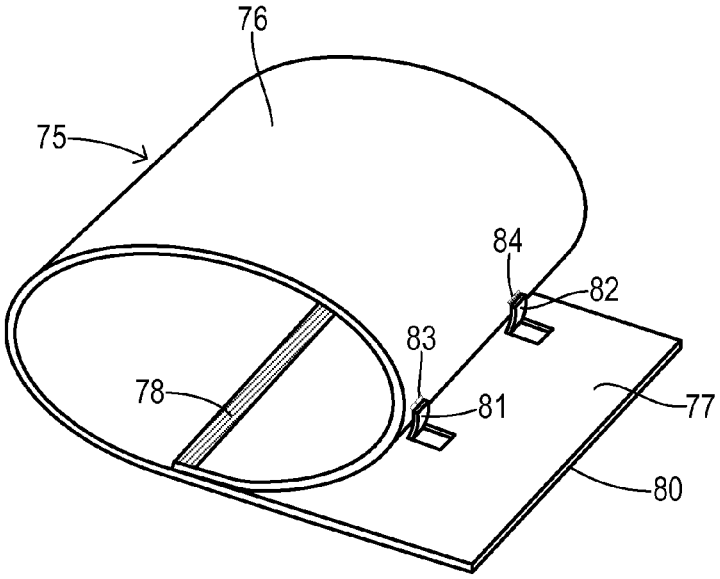


Fig. 10

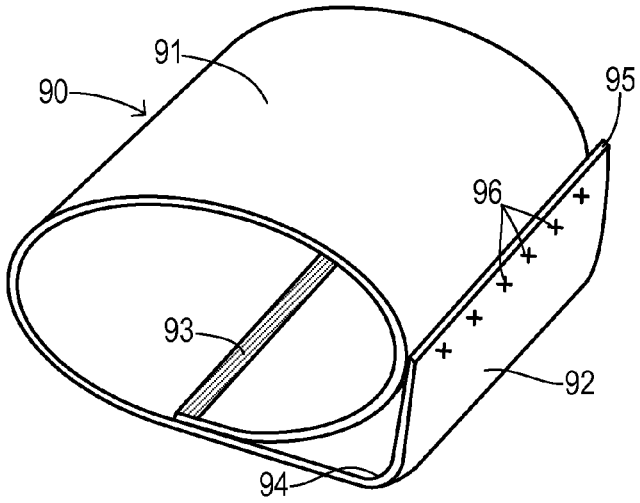


Fig. 11

MUFFLER SHELL BODY WITH INTEGRAL AERODYNAMIC SHIELD

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

Not Applicable.

BACKGROUND OF THE INVENTION

The present invention relates in general to mufflers for the exhaust system of vehicles with internal combustion engines, and, more specifically, to manufacturing a muffler shell from a sheet metal blank.

In the mass production of mufflers for the exhaust systems of motor vehicles and the like, a construction based on an outer, tubular shell made from sheet metal is commonly used due to advantages of low material cost and the availability of automated manufacturing processes and equipment. After forming the tubular shell, the addition of internal baffles, pipes, and end caps completes the muffler.

When installed into a vehicle such as a car or truck, a bottom side of the muffler is typically exposed to an open space beneath the vehicle. During vehicle movement, a high velocity air flow beneath the vehicle can interact with the muffler and any gaps, connecting structures, or protective liners/shields spaced from or surrounding the muffler. The interaction can create undesirable turbulence that affects vehicle performance and increases noise in the passenger cabin. The interaction can be especially pronounced when the muffler is mounted transversely to the direction of vehicle travel.

Applicant's co-pending U.S. application Ser. No. 14/549,188, filed Nov. 20, 2014, entitled "Muffler Shield and Muffler Assembly Employing the Same" (which is incorporated herein by reference in its entirety), discloses the addition of an aerodynamic shield to occupy a gap adjacent the muffler. In particular, a separate aerodynamic form is fabricated and then is attached to the outside surface of the muffler body. However, the separate fabrication and attachment of an aerodynamic shield structure to fill a gap around the muffler results in increased cost and manufacturing complexity.

SUMMARY OF THE INVENTION

In one aspect of the invention, a muffler shell is formed by a plate of sheet metal. The shell comprises a tubular body section wherein a first edge of the plate is welded to an intermediate seam line across the plate. An aerodynamic shield extension projects integrally from the tubular body section between the intermediate seam line and a second edge of the plate.

The plate is preferably a sheet metal blank, and various features may be provided on the shield extension using various manufacturing processes including stamping, punching, bending, folding, and rolling, such as the formation of stamped ribs to add stiffness to the shield extension. Rolling may preferably be used to then form the remainder of the blank into the tubular body section. Finally, a damping link may be formed between the shield extension and the outer surface of the body section (spaced away from the seam line) to reduce shield vibrations.

In a preferred method of the invention, a muffler is manufactured from a sheet metal blank. An aerodynamic shield is shaped adjacent a first end of the blank. A portion of the blank is rolled from a second end of the blank opposite the first end until the second end is proximate an intermediate seam line. The second end is welded to the blank along the seam line to establish a tubular body section, wherein the aerodynamic shield integrally extends from the body section. Then end caps are joined to tubular ends of the body section.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a muffler with a separately formed aerodynamic shield.

FIG. **2** is a perspective view of a rolled muffler shell with an integral shield extension according to a first embodiment.

FIG. **3** is a top view of the muffler shell of FIG. **2** with end caps.

FIGS. **4**A-**4**E show a sequence of rolling, welding, and bending of a metal blank to form a muffler shell.

FIG. **5** is a top view of a metal blank according to another embodiment wherein additional stamping and cutting provide additional shield features prior to rolling of the body section.

FIG. **6** is a top view of the metal blank of FIG. **5** after rolling of the body section and showing end caps.

FIG. **7** is a top view of a metal blank showing hemming along edges of the aerodynamic shield.

FIG. **8** is a top view of a metal blank showing stamped ribs and edge features for forming hems and gussets on the aerodynamic shield.

FIG. **9** is a cross section of the shield along line **9**-**9** in FIG. **8**.

FIG. **10** is a perspective view of a muffler shell with cutaway tabs linking the shield to the body section.

FIG. **11** is a perspective view of a muffler shell with a bend in the shield for joining an outside edge of the shield to the body section.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. **1**, a muffler assembly **10** includes a shell **11** with a tubular shape to receive end caps, including an end cap **12**. Muffler assembly **10** extends generally in a longitudinal direction L, and when mounted transversely in a vehicle then a wind W flows over muffler assembly **10**. During forward travel of the vehicle, the direction of wind W is transverse to longitudinal direction L. To reduce turbulence created by wind W in a gap between the muffler assembly **10** and adjacent structures in the vehicle, a separate shield body **13** has been suggested in the co-pending application mentioned above. Shield **13** is attached to the outer surface of muffler shell **11** as shown. Muffler assembly **10** may preferably have a generally elliptical cross-section, but may also include a conformal depression **14** to accommodate other vehicle components, such as a space for a spare tire, as known in the art.

Since shield body **13** is a separately manufactured component, it requires separate handling and additional manufacturing processes in order to attach it to an outer surface of muffler assembly **10**. To overcome these disadvantages, the present invention adapts the manufacturing process of forming a rolled muffler shell body in order to create an

integral aerodynamic shield as shown in FIG. **2**. Thus, a sheet-metal plate **20** is partially rolled so that a first edge **21** of the plate is aligned with an intermediate seam line **22** extending across the plate. Edge **21** is joined to a central portion of plate **20** by a weld **23** along seam line **22** resulting in a tubular body section **24** with an aerodynamic shield extension **25** projecting integrally from body section **24** between seam line **22** and a second edge **26** of the plate. End caps (not shown) can then be added to the open ends of tubular body section **24** resulting in a muffler assembly with an integral aerodynamic shield avoiding the separate manufacturing, handling, and mounting of a separate shield.

FIG. **3** is a top view of shell **20** illustrating the addition of end caps **27** and **28**. In this embodiment, end caps **27** and **28** are formed as male plug elements for being inserted into the open ends of tubular body section **24**, thereby avoiding any interference with aerodynamic shield extension **25**.

FIGS. **4**A-**4**E illustrate typical manufacturing steps for processing a muffler shell of the invention. In FIG. **4**A, a sheet metal blank **30** is coiled over a mandrel/roller **31** by a roller **32**. As blank **30** passes between rollers **31** and **32**, a curved portion **33** is gradually formed. After one full rotation of mandrel **31**, metal blank **30** forms a continuous loop together with an unrolled extension **35**. Having reached this configuration, one edge of the blank is now proximate to an intermediate seam line. In FIG. **4**C, a welder **36** is placed proximate the seam and is energized to create a weld (e.g., a fillet weld), thereby sealing the tubular body section. Alternatively, welding can be performed after removing the rolled blank from the mandrel/rolling machine in order to access the interior of the tubular body section for welding it from the inside.

Since an elliptical cross-section is typically desired for the finished muffler, the rolled blank having a circular cross-section may be placed in a press as shown in FIG. **4**D. The press has appropriately shaped tool surfaces **37** for compressing rolled blank **38** to give it an elliptical shape as shown in FIG. **4**E. It is also possible to simultaneously modify the shape of an aerodynamic shield extension **39** using an optional extension **40** on the tool surface. Alternatively, shaping of the aerodynamic shield extension may be performed prior to bending of the body section as is described below.

FIG. **5** shows a sheet metal blank **45** which has been pre-processed to add various features before the rolling of the tubular body section. In particular, one end of blank **45** is modified to provide various features on the shield extension. In particular, a shield extension portion **46** may include notched edges **47** and **48** to provide space at the longitudinal ends of the tubular body section for receiving female end caps (discussed below in connection with FIG. **6**). Notches **47** and **48** may be formed by punching or cutting, for example. In addition, the stiffness of shield extension portion **46** can be increased by adding stamped ribs **50**. Ribs **50** preferably extend perpendicular to an edge **51** of blank **45**. A dashed line **52** shows a location for introducing a central depression (either before or after rolling of the body section) to create the conformal section at the top of the muffler assembly that varies from the tubular cross-section. While a squared profile is shown for the shield in FIG. **5**, the edges may preferably be rounded or have other profiles for optimally filling surrounding gaps to minimize aerodynamic drag.

After rolling and welding of the tubular body section, a muffler shell **55** shown in FIG. **6** is created with shield extension **46** spaced away from longitudinal ends **53** and **54** in order to accommodate the placement of end caps **56** and **57**. End caps **56** and **57** may preferably be formed as stamped metal blanks which are attached to the rolled muffler shell by welding or using a rolled crimp as known in the art.

The edges of the shield extension may preferably be crimped or hemmed to avoid a sharp edge and to provide additional stiffness. As shown in FIG. **7**, a shield extension **60** projecting from a body section **61** includes edge tabs **62**, **63**, and **64** extending along respective edges can be folded over by 180° along the dashed lines in order to provide a hem. Tabs **62**-**64** can be formed during a stamping operation that cuts the notches that reduced the width of shield extension **60**, for example. A known folding or wiping operation can be used in order to produce the hem folds.

FIG. **8** shows a further embodiment wherein a shield extension **65** includes hem tabs **66**, **67**, and **68**. Shield **65** further includes gusset tabs **70** and **71** and a plurality of stiffening ribs **72**. The hem tabs, gusset tabs, and stiffening ribs may all be formed during a single stamping operation. Gusset tabs **70** and **71** are folded to a 90° angle as known in the art to provide added stiffness for shield extension **65**. FIG. **9** shows a cross-sectional view through shield extension **65** after performing folding operations wherein hem tab **66** has been folded over by about 180° and gusset tab **70** has been folded upward by about 90°. Gusset tabs **70** and **71** can also be incorporated with hem tabs **66** and/or **68**, for example. Furthermore, ribs **72** could have other arrangements such as crossing patterns or other embossed features (dimps and dents).

Since the shield extension is cantilevered from the weld seam with the body section of the muffler shell, additional reinforcement for the shield extension may be desired. A cantilevered shield extension may experience undesirable vibrations which can be reduced by adding a damping link between the shield extension and the body section (provided the damping link is spaced away from the intermediate seam line). The damping link reinforces the shield extension and reduces its ability to vibrate at lower frequencies.

FIG. **10** shows a first damping arrangement wherein a muffler shell **75** includes a tubular body section **76** and an aerodynamic shield extension **77** projecting from a weld seam line **78**. Between seam line **78** and an edge **80** of shield extension **77**, a damping link is formed using cutaway tabs **81** and **82** which are folded up from a central region of shield extension **77** in order to be attached to an outer surface of body section **76** by welds **83** and **84**. Cutaway tabs **81** and **82** may be formed by a punching operation.

FIG. **11** shows another embodiment wherein a muffler shell **90** has a tubular body section **91** welded to a shield extension **92** along seam line **93**. Shield extension **94** includes a bend **94** which causes an edge **95** of shield extension **92** to become juxtaposed with an outer surface of body section **91**. To form the damping link, a series of spot welds **96** join edge **95** to body section **91**.

Separate add-on elements (such as braces, struts, gusset pieces, or stamped bosses) could also be used for stiffening the shield extension and/or for providing damping links between the shield extension and the outer surface of the body section. Furthermore, various aerodynamic shapes can be utilized for the shield extension. The size, shape, and curvature for the shield extension can be adjusted in order to match the gap to be closed for any particular vehicle design.

What is claimed is:

1. A muffler shell formed by a plate of sheet metal, comprising:

a tubular body section wherein a first edge of the plate is welded to an intermediate seam line across the plate; and

an aerodynamic shield extension projecting integrally from the tubular body section between the intermediate seam line and a second edge of the plate, the aerodynamic shield extension directing transverse air flow away from the tubular body section.

2. The muffler shell of claim **1** wherein the shield extension is notched proximate the intermediate seam line to provide a reduced lateral width of the shield extension for accommodating end caps at tubular ends of the body section.

3. The muffler shell of claim **1** wherein the shield extension has at least one edge including a hem formed by folding over the at least one edge.

4. The muffler shell of claim **1** wherein the shield extension includes a gusset comprised of an external tab extending from an edge of the shield extension via a transverse fold.

5. The muffler shell of claim **1** further comprising a damping link between the shield extension and the body section, wherein the damping link is spaced from the intermediate seam line.

6. The muffler shell of claim **5** wherein the shield extension includes a bend juxtaposing the second edge of the plate with the body section, and wherein the damping link comprises a weld between the second edge and the body section.

7. The muffler shell of claim **5** wherein the shield extension includes an internal cutaway tab bent toward the body section, and wherein the damping link comprises a weld between the cutaway tab and the body section.

8. A muffler comprising:

a sheet metal blank formed into a tubular body section and an aerodynamic shield extension, wherein a first edge of the blank is welded to an intermediate seam line across the blank to close the body section, wherein the shield extension projects integrally from the body section between the seam line and a second edge of the blank, and wherein at least a portion of the aerodynamic shield extension is non-contacting with the tubular body section; and

end caps joined to tubular ends of the body section.

9. The muffler of claim **8** wherein the shield extension is notched proximate the intermediate seam line to provide a reduced lateral width of the shield extension for accommodating the end caps.

10. The muffler of claim **8** wherein the shield extension comprises stamped ribs extending perpendicular to the second edge of the blank.

11. The muffler of claim **8** wherein the shield extension has at least one edge including a hem formed by folding over the at least one edge.

12. The muffler of claim **8** wherein the shield extension includes a gusset comprised of an external tab extending from an edge of the shield extension via a transverse fold.

13. The muffler of claim **8** wherein the shield extension includes a bend juxtaposing the second edge of the blank with the body section, and wherein the muffler further comprises a weld between the second edge and the body section.

14. The muffler of claim **8** wherein the shield extension includes an internal cutaway tab bent toward and welded to the body section.

15. A method of manufacturing a muffler from a sheet metal blank, comprising the steps of:

shaping an aerodynamic shield adjacent a first end of the blank;

rolling a portion of the blank from a second end of the blank opposite the first end until the second end is proximate an intermediate seam line;

welding the second end to the blank along the seam line to establish a tubular body section, wherein the aerodynamic shield integrally extends from the body section to direct transverse air flow away from the body section; and

joining end caps to tubular ends of the body section.

16. The method of claim **15** wherein shaping the aerodynamic shield is comprised of stamping of ribs into the shield to add stiffness.

17. The method of claim **15** wherein shaping the aerodynamic shield is comprised of bending to form at least one of a hem or a gusset.

18. The method of claim **15** further comprising the step of forming a damping connection between the aerodynamic shield and the body section remote from the seam line.

19. The method of claim **15** further comprising the step of notching the blank at the first end to provide a reduced lateral width of the aerodynamic shield for accommodating the end caps.

20. A muffler shell formed by a plate of sheet metal, comprising:

a tubular body section wherein a first edge of the plate is welded to an intermediate seam line across the plate; and

an aerodynamic shield extension projecting integrally from the tubular body section between the intermediate seam line and a second edge of the plate, wherein the shield extension comprises stamped ribs adding stiffness to the shield extension.

21. The muffler shell of claim **20** wherein the stamped ribs include a plurality of ribs extending perpendicular to the second edge of the plate.

* * * * *